

# NASA TECH BRIEF

## *Goddard Space Flight Center*



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### Radiation Hardening of Metal-Oxide Semiconductor (MOS) Devices by Boron

#### The problem:

Ionizing radiation frequently alters the operational characteristics of MOS devices. One common radiation damage in MOS devices involves shifted gate threshold potentials, which renders the devices unstable and often inoperative. The present methods of protection from this radiation, using shielded enclosures, have not been effective. Shielding material adds substantial weight to the circuits and, if poorly designed, transmits much radiation.

#### The solution:

A radiation-hardening technique using boron effectively protects MOS devices from ionizing radiation without the use of shielding materials.

#### How it's done:

In this technique, boron, or another element with acceptor properties, is introduced into the insulating gate oxide layer at the semiconductor-insulator interface (see Figure 1). Boron concentration within the layer is approximately  $10^{18}$  atoms/cm<sup>3</sup>, the gate oxide being 10.0 to 30.0 nm in thickness.

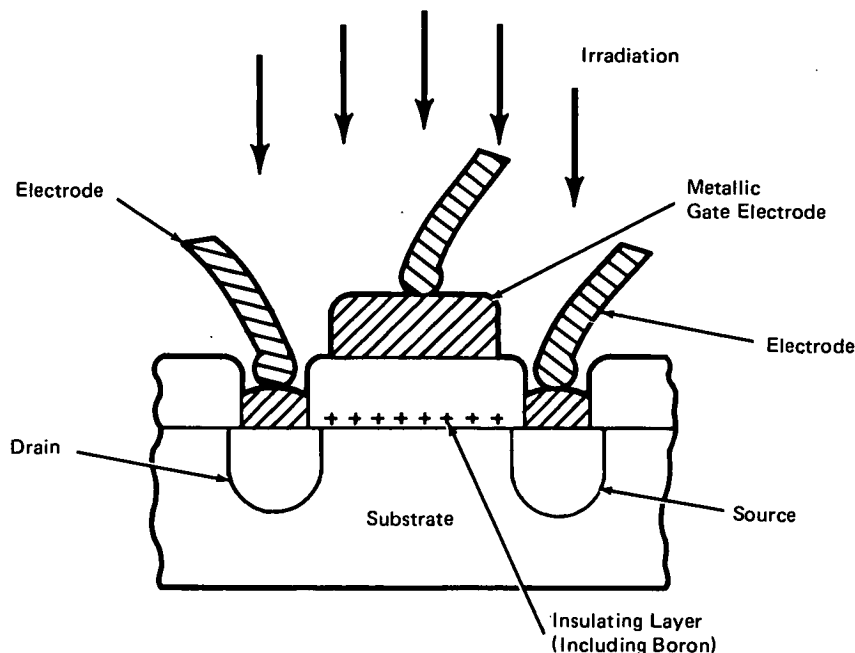


Figure 1. MOS Device

(continued overleaf)

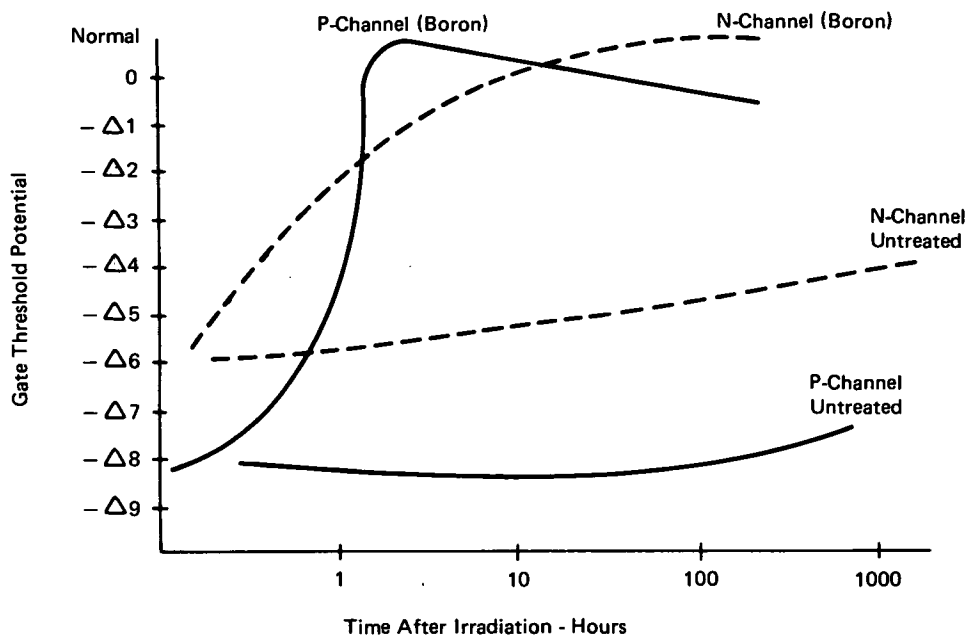


Figure 2. Gate Threshold Potential of P-Channel and N-Channel MOS Devices as a Function of Time After Irradiation

The resulting improvements in MOS performance are shown in Figure 2: the devices have been irradiated with  $10^{13}$  electrons/cm<sup>2</sup> at 1.5 MeV. The two upper curves shown are the improved recovery times for a p-channel and n-channel MOS containing boron. The two bottom curves are for the untreated p-channel and n-channel MOS showing recovery after irradiation. In this case, boron-treated, p-channel and n-channel recovery times are approximately 3 and 8 hours, respectively.

#### Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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